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Project Paper

Land Classification and Soil Survey
279-0042

8/17/78

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT PAPER FACESHEET

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10. ESTIMATED COSTS ($000 OR EQUIVALENT $1 -)

A. FUNDING SOURCE	FIRST FY B. FX	FIRST FY C. L/C	FIRST FY D. TOTAL	LIFE OF PROJECT E. FX	LIFE OF PROJECT F. L/C	LIFE OF PROJECT G. TOTAL
AID APPROPRIATED TOTAL						
(GRANT)	(409)	(77)	(486)	(409)	(77)	(486)
(LOAN)	( )	( )	( )	( )	( )	( )
OTHER U.S. 1.						
OTHER U.S. 2.						
HOST COUNTRY		40	40		40	40
OTHER DONOR(S)						
TOTALS	409	117	526	409	117	526

11. PROPOSED BUDGET APPROPRIATED FUNDS ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	PRIMARY TECH. CODE C. GRANT	PRIMARY TECH. CODE D. LOAN	E. 1ST FY 78 F. GRANT	E. 1ST FY 78 G. LOAN	H. 2ND FY — I. GRANT	H. 2ND FY — J. LOAN	K. 3RD FY — L. GRANT	K. 3RD FY — M. LOAN
(1) FN	191	092		486					
(2)									
(3)									
(4)									
TOTALS									

A. APPROPRIATION	N. 4TH FY — O. GRANT	N. 4TH FY — P. LOAN	Q. 5TH FY — R. GRANT	Q. 5TH FY — S. LOAN	LIFE OF PROJECT T. GRANT	LIFE OF PROJECT U. LOAN
(1) FN					486	
(2)						
(3)						
(4)						
TOTALS					486	

12. IN-DEPTH EVALUATION SCHEDULED: NA (MM YY)

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1 (1 = NO, 2 = YES)

Mission Clearances
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SIGNATURE: R Heisinger

TITLE: Mission Director, USAID/Sana

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LAND CLASSIFICATION AND SOIL SURVEY
Project Paper
(079-0042)

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I. Summary and Recommendations

A. Face Sheet

B. Recommendations

This project is authorized as a USAID/Sana approved project at a cost of $486,000. The life of project is two years commencing September, 1978. The Host Country 25 per centum contribution to this activity is waived per State 211050 (see Annex C, Waiver of Host Country Contribution).

The project can be a part of a larger and longer range project and identifies selected phases of activities within available funds and time-frame limits. It specifically provides basic resource information that will be necessary to the undertaking of future, more detailed soil and land use surveys. At the same time, the information provided will be useful in structuring the longer range planning of Yemeni agricultural activities as well as related social, cultural, and economic development programs.

A training component within the project will lead to the continuation of land use programs within the YARG on a more permanent basis. The land use and soils information will be made available for use as an essential element of the YARG's future planning and development activities.

Briefly, the scope of project activities are as follows:

1. Preparation of land use information and analysis from Landsat imagery;

2. Preparation of soil maps of Yemen W 45°30'/longitude at 1:500,000. A 1:250,000 scale map will form the data base for the land use system;

3. A time lapse analysis of land use with 1972 used as a base period. NASA will cooperate on the project by turning on Landsat III for coverage of the desired area. Satellite channels 4, 5, 6, 7, and 8 (a new thermo channel) will be utilized; and

4. Training of one or two indigenous soil scientists for a period of 18 months will be undertaken. The training will include the analysis, interpretation, formulation of procedures and study of satellite imagery; soil classification in soil toxonomy and correlation of land use and geomorphology from remote sensing applications in relation to soil field work.

At the conclusion of these activities, it will be determined where the most suitable lands for agricultural use and development are located in Yemen in order to plan, program, and develop agricultural projects that will be economically feasible and viable.

Project Rationale:

The concept of a land resource inventory implies that the components or resources directly related to the composition of land will be inventoried. Various concepts exist concerning the identify of components that make up land. Some look at land as associated to physical characteristics or conditions while others look at it in terms of its utility or use.

A major objective of the process is to design the inventory project to meet the needs of Yemen. The project will achieve the following: (1) produce a series of useful products and identify areas to which technology could be transferred, based on knowledge of land use; (2) locate areas where more detailed soil information would facilitate knowledge and introduction of new technology for crop production; (3) train Yemeni nationals where feasible; (4) formulate an operational, continuing information service in the country; and (5) lead to development of a complete resource information system.

The basic concept of land as applied in this project paper is to consider topography, soils, climate, and location as the major components of potential land development. In the case of Yemen, limited sources of information are available in the following areas:

Topography: Air photos
Satellite imagery
British maps at 1:250,000

Climate: Very limited practical information is available. Climatic data usually must be acquired for extended periods of time to provide highly useful information; this element is considerably deficient for this project.

Soils: Only "spotty" data sources exist. A few soil surveys have been undertaken, but they have not been generated in a logical or sequential pattern. Selected areas of land have been surveyed in varying degrees of detail, with little or no preliminary identification of soil types or soil description preparation. This fact limits or prohibits transfer of technical knowledge from other locations in the world to Yemen.

Location: Location elements of land relate not only to longitude and latitude, but also concern access by various types of transport; use; availability of services, etc. The characteristics of location can be however inventoried and information thereof utilized by the process of geographic referencing.

The fact that the British are reported to have prepared 1;250,000 topographic maps is helpful in meeting the goals and objectives of the project. Several items will be provided from this source of information. In particular, the UTM grid system will be developed along with the general location of many features of value in the inventory process. The British effort will allow the pursuit of the practical application phase of the project much more quickly; provided their maps can be made available to this project.

The process by which meaningful results may be obtained rapidly to meet the need for agricultural information includes a series of steps. If followed in a logical sequence of development, Yemen could move rapidly toward development of an information system that will locate areas that should be most responsive to new or different technology and where soils can be used to identify potential sites for "transferred" technology.

It is not usual to find a country where the "idealized" approach to resource inventories can be applied in such a logical sequence. This includes looking at the country and its land resources, using broad concepts to identify major areas for exclusion from more detailed approaches. Explorations based on progressively larger scales can be undertaken which allow for the exclusion of areas in successive degrees of importance, and lead to the identification of areas of potentially high response.

The sequence of steps proposed in this Phase are as follows:

1. A land use map (using vegetative cover) based on interpretation of satellite (ERTS) imagery. A limited number of use types to be identified (a generalized landform map could be prepared from the same materials). Scale: 1:250,000. Classification definitions are descriptions included. Minimum map unit would be close to 100 acres. (1/10 of an inch square, at a scale of 1:250,000 equals about 100 acres.)

2. A small scale map (1:500,000) of the major soils regions of the country (study area) indicating phases of associations of sub-groups as recognized by USDA soil taxonomy. Up to 1,000 soil samples will be taken, developed, and documented throughout the country to support this effort.

3. Time lapse analysis of satellite imagery of land use changes, based on 1972 and newly acquired imagery. This will provide the first indication of rates of change and kinds of change in land use in the country.

C. Project Description

The use of satellite imagery as a source of data concerning land use analysis is now an accepted practice in a number of situations. Classification units include a level I and level II system of classification of

land use. Actually vegetative cover, its density, or lack of it, is used as a prime surrogate for the land use identification process.

This phase of the project would classify land use in Yemen, according to the basic level I classification system, with some appropriate modifications. The level I units seek out:

Urban and built-up land
Agricultural land
Rangeland
Forestland
Water
Wetland
Barren land
Tundra
Perennial snow or ice

Not all units identified in the level I system are expected to be present in Yemen. In addition, it could be very useful to have more detailed classification of some units, such as Agricultural land or Rangeland.

The work would be carried out primarily through the use of manually processed satellite imagery, prepared to a scale of 1:250,000, and with areas mapped according to level I modified classification. Only limited field checking would be undertaken, but two functions would be developed to aid in verifying the classification decisions. The description of the classification units will be written in the field. Therefore, efforts to prepare good description will include travel to Yemen, and photographic support in the form of ground-truth photographs of land use in the various classification units.

The second form of support data would be the use of the aerial photographs flown by the British in 1973 as a source of ground-truth documentation.

This phase of the project calls for most of the work to be carried on outside of Yemen. One counterpart person would be involved with this work, and would be trained in the United States on the preparation and use of satellite imagery for manual interpretation.

In as much as so little is known about land use in Yemen, the ground-truth effort is essential in establishing an appropriate classification system for use with any form of remote sensing, including aerial photography. Whatever can be prepared at this time will be of major value in any subsequent efforts to carry out more detailed land use inventories.

The area to be studied lies west of the 45°30'/longitude, and includes all of the major populated area of the country. There are some uninhabited desert areas to the west of 45°30'/longitude that will not receive high priority and may be excluded from the study.

British Map Information:

The British are reported to have a set of 1:250,000 scale map under preparation. These will be utilized as a base map for the area to be studied. Their legend identifies very limited amounts of area land use information, including only two units for cultivation, scattered trees, and low growth. There are seven elevation units, from 0 to over 1,800 meters, and contours at 100 meter intervals with supplementary and approximate contours.

The British mapping program includes a project to enlarge the 1:250,000 maps to a scale of 1:500,000. They are adding considerably more detail to these maps, but it is understood that little additional information is to be prepared. They have identified nine map units that relate to vegetable cover and include areas in trees, bushes, grass, domestic palms, terraced cultivation, bunded cultivation, plantations, marsh or flood land, and open space. The above units are not the same as those obtainable from the satellite imagery, and they would not be readily obtainable from a time-lapse study effort.

There is a major problem in attempting to incorporate the land use information from the British map series in that no descriptive material is provided for the area units of classification.

The British maps will be used as a basis for geographic referencing of data, and for the generation of the UTM grid for the country. The basic land use information to be developed for this project would be derived from satellite image interpretation and very little of the information prepared will duplicate that on the British maps.

Statistical Data Summary

Area measurements will be made of the information prepared from this survey. The data will be summarized, and will be a form of geographic referencing. There appears to be no generally accepted level of government below the national level that would serve as a system for area referencing of data; so for the present, the data will be geographically referenced by use of the UTM system, in units of appropriate size for this effort. Data may be aggregated in larger units where degree of significance is low. But, in general, the UTM kl^2 cell system will serve as the basic referencing unit.

A Generalized Soil Survey:

The second major phase of this project would be the development of a generalized soil survey, scale 1:500 000, based upon interpretation of remotely sensed data and field correlation. This will require field work, which will be complementary and fundamental to the future development of a detailed soil surveys of anticiapted areas of high response to more intensive development and use.

Because of the importance of soils as a natural resource in Yemen, both general and detailed soil maps are essential for improvement in selecting and planning projects. The quality of the soil mapping is directly dependent upon the amount of fieldwork invested in the soil mapping effort. Therefore, it is essential that the soil survey be a part of any integrated short-term and long-term effort of resource inventories. At least one experienced soil surveyor with support equipment and personnel should begin fieldwork soon to make a generalized soil map of the country. Additional soil surveyors should be added as quickly as possible to work in project areas mapping on aerial photographs at larger scales. As the soil mapping progresses, areas with developmental potential will be identified from the better qualities of the soils, and these can merit further attention for future project funding for potential agricultural improvement.

Fieldwork is essential to the soil survey process in Yemen because pits must be dug in the soils, auger corings must be made to depths of several meters, soil samples must be collected for laboratory analyses, and soil boundary lines must be drawn on aerial photographs to identify soil conditions that cannot be delineated by remote sensing alone. Fieldwork is necessary because the soil data are prerequisites for placement of the soils into Soil Taxonomy--by which technology transfer can then be accomplished for soil performance data into or out of Yemen. The soils of Yemen are presently not classified in the Soil Taxonomy system, so that there is no systematic detailed format by which soils of Yemen can be compared with other soils.

Training

As part of the soil survey, two counterpart soil scientists from the Ministry of Agriculture in Yemen will be sent to the United States for a training period of 18 months. The training will emphasize practical procedures and classification of soils of Yemen in Soil Taxonomy, and correlations of land use and geomorphology from remote sensing applications to soil fieldwork. Upon return to Yemen, these individuals will be better suited to condensing the generalized soil mapping already in progress, or already completed, down to more detailed applications at larger scales of soil mapping specific priority project areas.

Another product of this project will be a time-lapse analysis of land use change, based on interpretation of satellite imagery, and/or high altitude aerial photography. The emphasis of this step will be to do a modest amount of analysis of changes in land use, as well as provide a training opportunity for one counterpart person.

The earliest satellite data to be used is that of 1972 Landsat imagery. The time lapse, using the most recent imagery available will be carried out and will be a little less than a decade. During this period, a number of changes have occurred in Yemen. Power systems have been added to irrigation wells. The economy has responded to the influences of major changes in income in the rural areas. Changes have occurred in the management of many agricultural areas, items that can be identified through the analysis of time-lapse remote sensing imagery

to a degree that information of use in long-range planning can be generated.

The above description of the project is based on the availability of satellite imagery. In case it is not available from Landsat III, high altitude photography could be procured for the more significant parts of the study zone. In this way, a successful project can be developed with or without successful operation of Landsat III.

Project Output

Land Use Analysis—Satellite Image Interpretation:

1. Classification system for use with satellite imagery for Yemen.

2. 1:3,330,000 ratio chips for three (or more) wavelengths.

3. Film enlargements of imagery.

4. Diazo composites of study area for projection to 1:250,000.

5. Colored slide sets of selected locations (both diazo frames and ground shots).

6. Hard copy colored prints (if desired, and limited to funds available).

7. Statistical summary of land use information.

8. Maps of land use areas at 1:250,000.

Generalized Soil Information:

1. Generalized soil map, at scale of 1:500,000.

2. Soil descriptions of soils identified in the generalized map.

3. Laboratory reports of all samples used for classification.

Time-Lapse Analysis of Land Use:

1. Set of satellite chips for wavelengths used.

2. Film enlargements.

3. Diazo composites of study areas.

4. Colored slide sets of major examples of transition areas.

5. Maps of areas of change at 1:250,000.

6. Statistical summary of change in land use.

Training Program for Two Host Country Nationals

The effectiveness of use of both the land use inventory and the development of the generalized soil map will be greatly enhanced by the training of two host-country nationals. There is one person already identified as a potential candidate for training and a need to search for another trainee to train in the resource inventory elements of the project. The two trainees would need to be selected soon so that they would be available to work on the project when the more detailed mapping operations are undertaken.

The training program would consist of three component parts:

1. English language training at Georgetown University.

2. Academic study program under special student status.

3. Technical training relative to the soil and natural resource inventories.

It is proposed to train both trainees in the United States for eighteen months each. It would be more worthwhile to have their time committed more heavily toward the end of the project than at the beginning, as there will be less likelihood of periods of low activity at that time. The following time frame is proposed and should be flexible enough to allow any necessary changes.

With a starting date in September 1978, the following time-frame for their training program is projected as follows:

	Approx. Dates
Arrive in D.C. — early November	
English language training — Georgetown	2 mo. - Jan. 10
Contractor university orientation training	2 wks. Jan. 20
Course work as special students/Spring term	to May 10
Work on soil and land use projects	to Sept. 1
Course work as special students/Fall term	to Dec. 15
Work on soil and land use projects	to Jan. 20
Course work and work on land use and soil surveys	to June 1

This program provides two months of English language study; three semesters of course work, designed to accommodate their abilities, and approximately five months of training so they can gain work experience on the soil and land use inventory projects.

Budget Estimates:

Activity I: Level 1 land use map, based on ERTS satellite image interpretation.

Project coordinator (1 year)	$20,000	
Technical assistant	13,000	
Support personnel (Secretary, TDY)	10,000	
Fringe benefits @ 24.5%	10,535	
Overhead (on campus rate) 62.2%	26,746	
Travel and Communication	7,000	
Materials and Supplies	4,000	
Contingencies	9,128	
Inflation potential (7%)	7,029	
		$107,438

Activity II: Soil Sampling and Soil Mapping in Yemen

Project coordinator (1)	$20,000
Technical assistant (1)	13,000
Soil scientist (1) - resident in yemen (18 pm)	34,000
Support personnel (secretary)	10,000
Fringe benefits (24.5%)	18, 865
Overhead (44%)	33,880
Housing in Yemen	30,000
Allowances	2,600
Travel and Transportation	12,000

Soil sample analysis	3,000	
Communications	1,000	
Vehicles and equipment	30,000	
Vehicle supplies	2,000	
Publications	7,000	
Contingency	8,000	
Inflation potential	15,788	
		$241,133

Activity III: Time Lapse Analysis of Land Use from Satellite Imagery

Project coordinator (1 year)	$20,000	
Technical assistant	13,000	
Support personnel	4,000	
Fringe benefits (24.5%)	9,065	
Overhead (on campus rate 62.2%)	28,652	
Travel and Communication	4,000	
Materials and supplies	3,500	
Contingencies (10%)	8,222	
Inflation potential (7%)	5,755	
		$ 96,194

Training Program Budget

English language training ($785/man mo. 4 months)	$ 3,140	
Academic and work training at project site (32 man months @ 1,100)	35,200	
Travel allowances (2 round trip-Yemen to USA)	2,895	
		$ 41,235

SUMMARY BUDGET

1.	USAID			486,000
	A. Contract		379,000	
	Tech services....311,481 Training..... 21,000 Commodities 46,519			
	B. Commodities (A.I.D. procurred)		30,000	
	C. Other Costs		77,000	
2.	Host Country			40,000
	A. Counterpart Salaries	15,000		
	B. Office	25,000		

D. Summary Findings:

On the basis of information presented in this project paper, USAID/Sana has concluded that this project is technically sound and financially feasible.

The scope of project activities include the following:

1. Preparation of land use information and analysis from Landsat 1972.

2. Preparation of soil maps of Yemen 45°30'W at a 1:500,000 scale. The 1:250,000 scale maps form the base data for the land use system.

3. A time lapse analysis of land use. The 1972 period will form the base period. NASA will be requested to turn on satellite Landsat III for 1978 coverage. Satellite channels 4, 5, 6, 7 and 8 (a new thermo channel) will be turned on and will receive return beam vilicone.

4. Soil sample collection, analysis and soil survey in the field will be used as a truth finding measure to corroborate the data produced.

5. An 18 months training period for each of two Yemeni soil scientists, if available, will be carried out at the contractor institution headquarters in the United States.

E. Project Issues:

The Mission views the major requisite to timely and successful project implementation the prompt procurement of the British air photos. Therefore, as a condition precedent to initial disbursement, the Mission will request YARG cooperation in obtaining these photos.

II. PROJECT BACKGROUND AND DESCRIPTION

A. Background

Planning for development requires information. Ideally, we like to look at the present situation, and then record the progress from that point over time. In a few instances we may find compelling reasons to look backward in time, to generate a longer "trend-line" to use in guiding the decision process.

Yemen has great need for information on many complex, yet interrelated aspects of its activities in order to make decisions. Land use and soil information are only two of many such aspects, but knowledge about them becomes increasingly important as plans are made to search for higher crop yields, greater efficiency, and greater quality in the products of these natural resources. Of particular importance is knowledge regarding production response to various soils over a time period.

There is need for improvement in the standardization of new information sources as changes for progress occur. All too often one finds cases where little information has been gathered for specific areas with little attention paid to the interrelationship of this information to other areas. These small segments can seldom be amassed into an information base for a whole region or country due to the lack of standard acquisition and recording procedures. As changes (and development) occur, the demand for standardized data will increase when more interest is generated in the management of the production resources used in agriculture.

In the case of soils information, we search for highly standardized and well documented classification techniques because:

a. Soil information can serve as a vehicle for technology transfer between regions within Yemen, and from regions elsewhere in the world that display similar ecological conditions.

b. Mapping classified soils provides a means of geographically referencing their location and distribution, and allows us to relate the soil characteristics to other essential elements of production.

A sufficiently detailed taxonomic system is necessary to provide efficiency in these steps. The U. S. system is sufficiently detailed.

Land; the major component of agriculturally productive resources, requires equally thorough documentation. Variations in a number of factors, both social and economic, influence the availability and use of the land resource. As with soils, land use patterns should be recorded in a geographically referenced

base-line study, from which changes (trends) may be measured over short and long periods of time. Such a system allows for the monitoring of the rate of change, as well as locating places where changes occur.

As additional research in agriculture is undertaken, land use and soil surveys play a major role in tailoring the results of research to fit the requirements of the production area. This can result in greatly improved returns to investments in research.

1. Resource Inventory Feasibility

In the past, it was physically impossible to prepare inexpensive resource inventories unless there was a good transportation network. Even where the road density was high in rural areas, complex togographic features could severly restrict visibility and hamper inventorying of land resources and land use.

Since the early 1950s a number of developments have made it feasible to undertake resource inventories in more inaccessible areas and to provide accurate results at very low unit cost. The major improvement was the availability of aerial photographs, and the development of the skills necessary to interpret them.

Numerous new tools have been developed to improve technology for this work. Better cameras, better films, more stability of helicopters and aircraft, and the development of high-altitude aircraft are some of the major advantes. It is now possible to do as good work on land classification projects from high quality imagery at a scale of 1:100,000 as was used at a scale of 1:20,000.

Since 1970, scientists have made great advances in understanding the performance characteristics of major portions of the electromagnetic spectrum. This has been brought about by the work within NASA in the development of multispectral scanners for use in satellites that can observe, in surprising detail, the natural resources of the earth, and in many cases, provide the evidence needed to classify those resources.

One is no longer restricted to the use of visual survey techniques for the preparation of soil and resource inventories. The new technology has cut the cost of preparing such surveys to a small fraction of that of the previous systems. It has been necessary, however, to develop new theories and apply them to maximize the benefits from these new technological developments. New concepts of classification, geographic referencing and data processing have had to be developed to make use of the information sources.

2. New Concepts

A number of researchers in many countries have been working on the development of new concepts necessary to maximize returns of the newly developed technologies. Some examples include groups who have developed the

Canada Land Inventory, new computer technology at the Harvard University Center for Computer Research, the Land Use Inventory teams at Cornell, Michigan and several other states, the development of national land use classification systems for use with remotely sensed data, and the promotion of resource information laboratories and user services in New York, Connecticut, Wisconsin, Michigan and other states and countries around the world.

The basic concept necessary to fully utilize the new technology can be summarized as follows:

a. Develop information from any useful sources; air photos, field surveys, satellite imagery, or individual knowledge.

b. Process information in the most advantageous way for the proposed use. This may include data sheets, map preparation or computer products. But it should be geographically referenced in the process phase.

c. Provide information in any form desired. In this sense, the inventory can be considered to be a "warehouse of knowledge" from which the user of the information selects items that are useful to him, and specifies the format of this choice (map, statistical, etc.).

In developing a project, the first phase of the design process will involve discussion with the prospective users of the information to determine what kind of information they feel will be most satisfactory to meet their needs. This involves some determination of the kind of problem they hope to work on, and what information is missing and available.

The second phase will be a determination as to which source of information will be best to use to obtain a suitable degree of accuracy, most economically. The decision may lead to the use of air photos, ground surveys, satellite data, etc. The "processing" phase involves the actual compilation of the data; the development of classification that will satisfy the user's needs; establishment of descriptive material and ground-truth documentation of the various items to be inventoried, and development of the geographic referencing system to be used. The "data system" must also be established and prepared to accept this information. The "data system" may involve anything from work-books with coding pages up to sophisticated computer program systems. Processing may be performed manually or may involve machines. These decisions will reflect the needs and interest of the user; the kind of audience he wish to reach; the amount of time available, and the financial and technical resources available.

The geographic referencing of data also has been reconsidered in recent years, and new theoretical approaches have been applied. If any inventory is to be used over time and is to serve as a basis for analyzing trends, no matter what resources are being considered, there should be a means of letting the user know quite precisely to what geographic area each

unit of information applies. In most cases, this can be accomplished through the use of various mapping techniques.

In larger area surveys, or if summarized, data is required for a variety of areas; it is worthwhile to use additional devices to locate the point or area of occurrence of the data. There are a number of ways of doing this, but the most productive system is the use of some form of a standard grid system. The Universal Transverse Mercator grid system has been the most successful. This system uses metric units, can be applied anywhere in the world, and for a country the size of Yemen, each kl^2 can be located with only six digits or any hectare with only eight digits. Smaller units of ten square meters can be identified by only ten digits, etc.

The placement of the UTM grid cells is permanent, as are the numbers assigned to the cell. Thus, if time-lapse analysis is desired, (and it is a potent source of data for management decision making) the grid cells provide a permanent location system which allows us to go back to each individual kilometer or hectare to analyze any changes that might occur in land use, resource quality, or other characteristic of interest.

The geographic referencing system also is essential if we wish to effectively inter-relate a variety of resource information, such as climate, soils, land use, crop areas, and production records. The development of data for a variety of types of areas, such as districts, wadi basins, rainfall zones, etc., is also possible by re-aggregating the UTM cells to fit the shape and size of the area to be analyzed.

The new forms of sources of information have demanded the creation of many new concepts, but one most frequently overlooked is the need for new classification technology. We now work with remotely acquired information and wish to integrate it with many other forms of data. A certain amount of ground-truth is essential, but equally important, is the development of classification unit descriptions that satisfy the needs of the user, and can be applied by technical staff members to identify items as they appear on the remotely sensed data source.

Classification systems can be well used by technical staff if the unit descriptions are complete; mutually exclusive; identify the items as they appear on the source of information being used; identify what the ground situation appears to be (ground-truth) and exclude from the system items that might be accidentally included in the classification unit.

The third phase of the process involves taking the information that has been prepared and providing it to the user. If the first two phases of the work have been well developed then we should be able to prepare the information in some format that will be useful to any user. The final product may appear as maps, overlays, data sheets, computer print-outs, computer display maps, or even as publishable charts or graphs. In order to get the most benefit out of the data (which costs money) the third phase usually provides for the distribution of the information to all who wish to use it, a "safe"

storage facility, because it becomes more valuable over time, and a support for the maintenance of the data base, which may require some form of revision or addition from time to time. In several projects this function has been called a "User Service". It usually provides for promotion of the use of the data, and may also provide technical assistance to people who wish to work with the data.

3. Application and Maintenance

Inventories of any resource do not stand alone. All too oftenaa project is completed, the report is filed in a library, and that is the end use of it. The true value of a resource inventory and especially of soil survey information can only be realized if the information is utilized. Efforts to promote the use of the information need to be continuous; and best results seem to occur when a small, but technically proficient, staff is maintained to promote the use of the information; to maintain the materials developed for the inventory, and to assist people who wish a better understanding of how they might use the inventory.

In maintaining an inventory system it is desirable to be able to add new information as it becomes available, and to repair or replace damaged or lost data forms or materials.

Assistance to users and promotion of the inventory use does not require a large staff or expensive procedures. But it is necessary to help people learn how to use the material if the expected benefits from undertaking the inventory are to be realized.

B. Detailed Description

Originally, the duration of the complete project was estimated to be five years, subdivided into two phases. Phase one, which would cover the first two years, would emphasize products, i.e., the compilation, presentation and interpretation of data, although it would also include some training of Yemeni counterparts. Phase two, lasting three years, would involve the collection and interpretation of additional data but the emphasis would shift to development and institutionalization of Yemeni capacity to continue collection, interpretation and use of soil and land use information.

Phase one, which involves this project paper, is designed to yield products which will be useful even if the project is not continued beyond that stage. However, if the project proceeds as originally planned, it seems likely that the value and utilization of phase one products will be enhanced by a continuation into phase two. Extension of the project into phase two will depend upon a favorable review of phase one activities and phase two prospects. If a decision is made to extend; the scope and content of phase two will depend upon assessment of needs and project development hence.

1. Phase One

The objectives of Phase one, upon which this project paper is focused, are to produce the following:

a. A land use map of Yemen at a scale of 1:250,000 showing a limited number of land utilizatiou types (such as irrigated areas, range areas, urban areas, etc.) which can be recognized on Landsat imagery. This map would be equivalent to the Level I classification described in Geological Survey Professional Paper 964. The report will include description of the classification units of land use.

b. A map at a scale of 1:500,000 of the major soil types in accordance with U. S. taxonomy. The total volume of the soil survey in phase one will be performed in 24 months. Up to 1500 soil samples are to be analyzed by the FAO-assisted Central Agricultural Research Station Soils Laboratory at Ausseifere (Taiz). The analyses will include: texture (pepette), cation exchange capacity (NH_4Ac, pH8), exchangeable Ca, Mg, K, Na, organic carbon, total nitrogen, pH, $CaCo_3$, and conductivity. The base maps will be procured from the British.

c. Time-lapse analysis of satellite imagery to measure recognizable changes in land use, cropping patterns, etc. Imagery dating back to 1972 would be studied to form a base period to compare with the most recently available coverage.

d. The academic/special training of one to two Yemeni soil scientists in satellite interpretation and soils analysis.

III. PROJECT ANALYSIS

A. Technical Analysis, Including Environmental Assessment

Yemen is probably among the least developed countries of the world. Most statements about the country, based on statistics, are open to question. There is little knowledge on Yemen's most basic resources. Among the types of resource information that would be most useful in planning and development to meet the needs of the people of the country are knowledge about the soils and land use of the country. It is no longer necessary for a country such as Yemen to be left with essentially no information on soils or land use at a time when the ability to produce a knowledge base for this kind of information has been greatly improved in the past few years.

The main objective of this project is to initiate development of basic resource information. This will be accomplished by establishing the first soil classification system and land use classification system (generalized) to be applied to the arable part of the country.

Technical Feasibility

Recent technological developments have greatly increased our ability to aid a developing country in generating its basic resource information. Through various forms of remote sensing, including aerial photographs, satellite remote sensing, and high altitude photography, it is now possible to analyse land use, and to a lesser degree generalized soil information for areas that were not feasible in the recent past. These sources of data are particularly suited to the initial phases of this kind of work.

Recognizing the need to relate classification systems directly to the capabilities of the sources of information, a land use classification system for use with remote sensor data was prepared by the U. S. Department of Interior. The system has been tested and found to be satisfactory for use throughout major portions of the U. S. and the world. With appropriate modifications, it should be equally useful for this project in Yemen.

The remote sensing phase of the project can be approached from three different avenues of expertise. Work can be carried out by completely automated processing, and some of the land use information but little of the soils information, could be acquired this way. This approach was not recommended because of its cost; its questionable effectiveness in areas with little or no opportunity for ground-truth information, and its complexity, which limits its usefulness to highly skilled technical staff in the host country.

The second approach is to provide for manual interpretation of machine processed imagery. This approach is not recommended for essentially the same reasons as those related to the first approach.

The third approach includes manual processing and interpretation. Its low cost allows good results without the use of sophisticated hardware; permits interactive involvement of the interpreter throughout the process (thereby overcoming, in part, at least, the lack of ground-truth information) and can be readily understood by host-country trainees. These processes are documented, and are in the NTIS files as part of the report materials prepared by researchers on the NASA sponsored Landsat and Skylab research programs.

Although the processes proposed for the interpretation of multi-spectral data are manual, and low-cost, the product that will be prepared will be at the desired scale (1:250,000) and the data on which the prepared maps are based will be essentially the same as that acquired by the other two approaches. With these considerations in mind, the manual processing interpretation methods have been selected for use in this project.

Time-lapse analysis of satellite imagery provides unique opportunities to acquire geographically referenced change analysis data at low cost. This is performed by using selected wave lengths of satellite imagery from an early year (1972) and combining that with the same or conflicting wave lengths from subsequent periods of time such as 1978. The areas where land use has changed will stand out in contrasting colors. This is a straightforward process for identifying areas of land use change. In general, the changes are color identified, and geographically located simultaneously by the use of this process.

The method requires no further research and is presently in use in a performance mode on large area projects in the United States and other areas of the world.

Generalized Soil Map

Satellite procured imagery can be of considerable use in identifying the basic land forms of large areas of land. It removes the problem of trying to find ways to acquire ground base information from all of the area under survey. Experienced soil scientists are capable of analysing the general land form structures, and from them, establish a first estimate of what the general soil associations might be according to the identified land form. The 1973 cover of air photos of Yemen would be essential as ground support information for the development of this mapping effort.

This approach is much more productive if basic information can be prepared to support the interpretations. In terms of developing a "generalized" soil map for a country such as Yemen, a limited number of soil profiles need to be described, and chemical analysis provided. With this information it is possible to verify a substantial proportion of the soil boundary decisions, at least as a scale of 1:500,000.

All the sample profiles and chemically analysed samples remain as useful components for use with subsequent detailed surveys.

As far as technical work requirements for this project are concerned, all of the necessary resources are available to undertake the project. The satellite imagery will be prepared to a scale of 1:250,00 for use in preparing the land use classification survey. The FAO Laboratory at Taiz is equipped to carry out the chemical and mechanical analysis of the soil samples that would be required.

In view of the fact that all the technical processes needed for this project and the facilities are already in operation in the United States (remote sensor processing) and Yemen (soil laboratory at Ausseifera); there should be no problem in the implementation of the project.

One driver and 18 man months of labor equivalent would be required for this part of the project. Also, one vehicle for use by the soil mapping team will be needed. Travel accommodations will be also required for short periods of time for field work on the land use mapping survey.

There is one possible technological problem that should be considered. Not all of the satellite imagery of Yemen is of equal quality, nor of useful dates. In fact, there is no complete coverage from 1972 to the date of this writing. This is due to the failure of transmitting devices on the satellites involved. Currently we are not positive that Landsat III will provide coverage of Yemen, although there is a good possibility. In addition, it may be necessary to acquire Yemen satellite imagery through some source other than the EROS Data Center. In case this becomes a reality, the time-lapse analysis phase of this project may require modification. Possible modification will include samples based on air photo acquisitions.

Information regarding availability of satellite imagery from Landsat III have been filed for the project.

B. Environmental Assessment

There would be no environmental degradation associated with the land use survey or the time-lapse analysis of land use. The raw data will be acquired by remote means, and processing and analysis will not take place within Yemen except for the analysis of soil samples taken in the country.

There will be need for travel by soil scientists who will spend up to 4 weeks travelling in selected areas of Yemen. This will not cause any environmental degradation.

The soil mapping operation will be carried out in a fashion similar to that of the land use inventory. No environmental problems are expected from the remote sensing work on the soil classification part of the project.

A very limited action affecting environmental concerns would be generated in the soil sample phase of the project. Small areas of banks or soils will need to be dug to expose the profiles of the soils. In some cases

these will need to be extended along a linear front sufficient to expose cyclical occurances in the profile. The soil profile areas will be filled in immediately after they have been described. No lasting effect on the environment could be expected to be created by this activity.

The field team working on the description of the soil profiles will consist of three or four people. They will travel through much of the country on its major roads, but will not create any demands on the environment above any normal travel in the area.

No activities will be carried out in Yemen that would be expected to create any environmental damage in any way.

C. Financial Analysis and Plan

Most of the work on this project will be carried out in the United States. Therefore, direct financial support within the host country will be limited. It is rather difficult to identify the economic benefits in verifiable quantitative terms at present. However, there are subjective assessments that can be advanced. There will be substantial benefits from developing and using the information about the country's land use and soil resources that this project will provide. Without this basic information, there will remain a risk of lengthy delays in improving agricultural production, and the ever-present possibility of assigning development funds to unresponsive land areas.

The purpose of developing this resource information base is to identify areas of two types. First, it is important to identify areas that appear to have little or no potential to respond to technological inputs, thus allowing concentration of resources where potential of success is highest. And second, areas suitable for high concentration of resources, that is, suitable for intensive production, including some form of irrigation, will be brought out to the attention of economic planners for Yemen.

In view of the above circumstances, there appears to be strong justification for this project in anticipation of benefits occuring in the form of greater productivity from the agricultural sector of the economy, better project designs for future AID agricultural projects, and better response to fund expenditures for agricultural sector development. Direct benefits to local farmers and land owners are expected, but will be difficult to identify at this stage of project proposal. It is logical to expect improvements in cropping patterns, better research work in high-level response areas and should therefore lead to the use of improved production practices. Improvement in the level of rural family living will be a long range benefit of the project.

This project is not a direct revenue generating effort in its early stages. Its benefits will be substantial, but not quantifiable in the usual cash flow analysis pattern. Because of the above circumstances, financial analysis at this time is difficult to develop. However, there are no negative responses to be concerned with, and expectations for future economic improvement will be positive.

D. Social Analysis

Social impact expectations are similar to the economic and financial expectations. As there will be limited contact between project staff and host-country personnel a limited direct social impact could be expected save for the training of indigenous personnel under the porject.

Over a longer period of time there should be a significant social impact; especially in the rural farm areas. That will be a logical expectation by selecting the more responsive land areas within which to apply scarce resources in the future. We can anticipate definite improved social change in consequence to this activity.

Improved and diversified agricultural production to meet the increasing food requirements of Yemen will be expected as a result of the agricultural resource inventory through this project. Also increased agro-business activities will develop and help small farmers and women to increase their income.

Women constitute over 50 percent of the farm population and have been increasingly taking responsibility for crop cultivation in view of the migration of large numbers of their men folk to neighboring oil producing countries. Therefore they stand to benefit most from this resource inventory and eventual development of their land.

IV. IMPLEMENTATION PLAN

A. Administrative Arrangements

This project would be administered under the direction of the Mission Director of USAID/Sana. Cooperation between the Contractor and the Yemeni Ministry of Agriculture, the Yemeni Planning Office and the Ministry of Public Works will be maintained throughout the life of the project.

The project will require limited field staff input for the soil mapping effort. This personnel resource would be selected from the Yemeni Ministry of Agriculture or elsewhere in the host country.

B. Implementation Plan

There are a number of products to be generated in the course of this project. They have been listed in the background section of this paper. In the course of developing these products various activities are required in sequence in order to develop fruitful results. The following information, relating to these activities, need to be followed to develop the desired project outputs.

Activity #1 Satellite based inventory of land use, using 1972 imagery

1) Acquisition of 1972 Landsat I imagery from NASA - EROS Data Center scale 1:3,300,000. Processing of test chips undertaken. Simultaneous acquisition of back-up information, including maps, air photos, literature, etc. concerning the physical, cultural, and economic characteristics of the country.

2) Develop classification system, write descriptions, and prepare ground-truth photos. This will require field work for 2 people in Yemen. The writing of descriptions of the classification units is most effective when carried out in the local of expected application. At the same time, photographic material, identifying the classification units, as well as the extremities of the units (parameters) will be acquired. Transportation and driver to be provided by AID Mission in Yemen.

3) Preparation of enlarged satellite imagery. Laboratory processing is required to enlarge the satellite imagery from 1:3,300,000 to suitable scale for projection to 1:250,000. This is a dark-room process, that requires substantial technical capability. There will be approximately 15 satellite scenes to be processed.

4) Preparation of land use maps. Land use maps will be prepared for designated study portion of the country (most of the area west of Longitude 45°) at a scale of 1:250,000. This will be carried out by projecting

the satellite imagery to the desired scale, and through color differentation, identification of the areas will be performed. These areas will be selected, where the decisions made from satellite image interpretation will be evaluated in relation to areas where air photo interpretation has been undertaken. These will be relatively small test areas.

5) Develop geographic referencing and UTM grid system. A grid possibly as small as 1 kl^2, needs to be prepared for the study area at a scale of 1:250,000. This provides the geographic referencing basis for the inventory. This will be raised from the 10 kl^2 grid presently available on the British 1:250,000 map series.

Coding forms suitable for encoding the land use data will be prepared and tested as well.

6) Data summarization. The data will be extracted from the map forms and encoded on data form. (It will be suitable for incorporation in computer format, but this project is not intended to computerize the data.) Summary records of areas of the different kinds of land use will be prepared.

Simultaneously, copies of the final maps will be prepared for reproduction.

7) Deliver to USAID/Sana the products of this part of the project. Explanation on the use of the materials produced to YARG will help in a much more rapid return of benefits from this effort.

Activity #2 Generalized Soil Map (scale 1:500,000)

This work requires the use of a project vehicle in Yemen for a period of 18 months. The following steps will be undertaken:

1) Acquire back-up information and order equipment. This time will be spent primarily in the U. S. The field vehicle will have to be ordered at the earliest possible date, as delivery delays at the port are anticipated to be 6 months or more.

Primary involvement will be in acquiring qualified personnel, and in becoming familiar with all the available back-up information about Yemen and the very sketchy soil surveys that have been prepared for small areas of the country.

(Note: The soil map phase of the project will have a 3 months delayed start-up date.)

2) Preliminary survey of satellite imagery, and selection of areas of anticipated high response. This phase requires some assistance in interpreting the satellite imagery of the area, and in associating the

imagery and other areas of knowledge. Through correlation processes areas of high response potential will be located, and preparations undertaken for more thorough investigation of those areas will be made. Areas where little or no response capability is anticipated also will be identified in this process.

3) Send soil scientist field man to Yemen. Approximately 3 months after signing the project the field supervisor and investigation leader should plan to leave for Yemen. A period of 8 to 10 weeks will be allowed for initial organization of field techniques, developing general knowledge of the study zone, and acquisition of necessary equipment and field personnel for subsequent work on the project.

4) Preparation of a base map at 1:500,000. The field survey data will be prepared in final report form on base maps at a scale of 1:500,000. The reproducible base maps (on mylar) will be prepared in the U. S. They should be prepared in such a way as to match the satellite images as closely as is feasible.

5) Collection of soil samples in pilot areas, and documenting soil descriptions. This constitutes the main body of work on the soil mapping project. Pilot areas will be selected from previously prepared secondary sources of data. Field crews will prepare pits and profile areas for use in writing descriptions. Samples will be collected and delivered to the FAO Soil Testing Laboratory at Taiz. This work will continue as long as necessary.

6) Testing of soil samples delivered to FAO Soil Testing Laboratory at Taiz. No time commitment for project, as samples will be paid for on a unit basis.

7) Develop generalized map units. Relying on field data, laboratory reports, field experiences, and secondary sources of information, generalized soil units will be described and prepared for the final map preparation.

8) Preparation of generalized map and report. The final map and accompanying report will be prepared and delivered to Yemen. This work will be carried out in the U. S. with map preparation and report publication undertaken as the final objective of the project.

Work will continue on the collection of field samples and the preparation of soil description. The areas within which to concentrate this effort can be selected at later dates. One approach would be to concentrate on one area with high production potential. Yet it may be important simply to add to the pool of general knowledge about the soils by working in areas of limited production capabilities.

Activity #3 Time-lapse Analysis of Land Use Change from Satellite Imagery

In many ways this process will parallel the work of Activity #1. The base maps will be prepared during Activity #1, and much of the processing work needed for the time-lapse work will have been prepared. It is expected that there will be new imagery available from Landsat III with new wave lengths to test out. Of particular interest is band #8 which is the newly available heat sensitive band. In addition, the Return Beam Vidicon system should be tested as a source of desired information. If neither of the new wave length systems prove of value in this work, the project will be feasible through the use of Landsat III bands #4, 5, 6, and 7 (multi-spectral scanner). The following steps will be undertaken:

1) Acquire remotely sensed imagery from EROS Data Center.

2) Experimentation on suitability of the new wave lenghts available from Landsat III. This will be a series of short tests to determine whether or not the processing procedures that were developed for use with bands #4, 5, 6, and 7 are adequate for use with imagery from the additional wave lengths (bands) available from Landsat III.

3) Prepare materials for the enlargement process. This is a matter of taking the bands that have been selected and through the photographic enlargement processes previously developed, enlarge the imagery to suitable scales for projection.

4) Diazo transparency preparation. Using the bands selected from step 2, the enlarged negatives will be used to prepare diazo transparencies that will best isolate changes in land use. These must be combined with bands from the earlier (1972) imagery to provide the contrasts necessary to indicate changes in land use.

5) Field investigation. Satellite imagery readily identifies areas where a land use change has occurred, but the exact nature of the change is not identified. A short period of field investigation will be necessary to identify and describe the changes that are evident from the time-lapse imagery.

6) Develop map of areas of change. The imagery will be projected to a scale of 1:250,000 and areas of change will be mapped. Through field investigation in step 5, and with the use of air photos as supplemental information, the areas of change will be identified and located. The change detection will be based on changes that occurred subsequent to the 1972 period imagery that was interpreted for the work in Activity #1.

7) Summarize information. Prepare a statistical summary of changes in land use as identified in the time-lapse analysis of the satellite imagery, and prepare a report about the project.

Throughout the time committed to activity #3 there will be an opportunity to prepare visual materials. These materials should be developed and prepared as an on-going part of this process.

C. Evaluation Plan

This project is of relatively short term duration. But in looking at the time-frame established for each activity, it would be logical to call for three evaluation conferences, at approximately eight-month intervals. The evaluation would be primarily concerned with performance, effectiveness, and suitability of the materials prepared. The progress of the project would be assessed, and the actual time/product ratio evaluated.

Most of the technical work on this project will be performed in the United States with the exception of the field work on soils and the technical work on soil samples which will be carried out in Yemen. In view of this, the evaluation will be either in AID/W or at the contractor's location. Additional reviewers could be called on, if desired, by the Agency for International Development.

D. Conditions, Covenants, and Negotiating Status

The required technical capabilities for this project have already been discussed and no problems of execution are expected.

However, there are several conditions precedent to disbursement included in this paper which would affect its validity if not carried out.

Prior to initial disbursement

a) One host-country national is to be identified for academic and special training in the U.S.

b) The YARG will make available British aerial photographs needed for development of this project.

Specific details regarding the above will be the subject of subsequent project implementation letters.

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Project Title & Number: SOIL AND LAND RESOURCE INVENTORY FOR YEMEN

"ANNEX A"

Program or Sector Goal: Project will provide statistical, geographical reference system on land use, soil resources, and land potential on a nationwide basis. This information can be significant in directing research on crop and food production, getting up-to-date information used in the decision process, and providing the foundation of knowledge needed for improving the agricultural industry of the country.	**Measures of Achievement:** Increased use of resource information in the government planning and decision making process. Use of soils information to select research and experimental locations. Conversion of research results to areas where anticipated soils responses are at high levels.	**Production Results:** Records of use of material through resource information services. Yield records on commercial and test plots. Records of decisions made based on detailed soil maps and resource information.	**Assumptions for Achieving Goal Targets:** Host country is interested in establishing resource management practices. Host country wishes to acquire and use information of soils and other resources for decision making purposes. A better food supply with wider variety of products is desired by host country.
Project Purpose: 1. To provide information about land use and soil resources for better decision making processes. 2. To identify areas where detailed soil information could be of most value. 3. To aid in the location of areas of most response to new research efforts. 4. To train Yemen personnel in soil science and detailed soil survey, and in use of resource information. 5. To aid in improving the agricultural production of food supply and economy of the country of Yemen. 6. To aid in developing the best use of scarce natural resources in the country. 7. To provide training necessary to make use of modern techniques of natural resource data acquisition and dissemination (soils, climate, land use, etc.) 8. To provide information suitable to allow transfer of technical knowledge from other parts of the world to the Yemen situation (especially in relation to soil science and crop research).	**Conditions that will indicate purpose has been achieved:** End of project status. 1. Resource Information User Service equipped, staffed, and called upon for information to be used in decision making processes. 2. Land use information available to general public. 3. Soil maps available for important areas of the country. 4. Results of research from Yemen and elsewhere applied on the basis of the resource and soils information prepared in project. 5. Staff of Yemen technicians able to generate input and answer requests relative to soil survey and natural resource information. 6. Food and agricultural resources appear better adjusted to the needs of the country. 7. Other countries recognize results and request similar information and services. 8. Final report prepared and available.	1. Contractor records and publications 2. AID documentations 3. Reports from host country	**Assumptions for Achieving Purpose:** 1. The techniques and science background for carrying out the soil survey are available and suitable to the needs of this project. 2. The technical problems of using air photos, field survey, satellite imagery, and data processing for large area land use surveys have been solved. 3. Better use of land and soil resources will result from adaptation of information acquired from this project. 4. Decision makers will use the information the project can provide. 5. Suitable dissemination procedures (and personnel) can be developed within host country.

Project Title & Number: SOIL AND LAND RESOURCE INVENTORY FOR YEMEN

Outputs:	Magnitude of Outputs:		Assumptions for Achieving Outputs:
Generalized soil map. Generalized land use maps. Time-lapse analysis of land use change. Detailed soil surveys of selected areas. Detailed land use survey of agriculturally important part of the country. Soil classification systems. Land use classification system. Geographic referencing system. Trained technical staff of Yemen personnel. User survey organization for the country of Yemen.	Reports and papers on various phases of the work proposed. Resource information and land use data for the country west of the 45th longitude prepared at scale of 1:50,000. Detailed soil surveys for selected, responsive areas within the work region prepared. Trained personnel available and training for general use made available. User service, storage, and reproduction of resource and soils information generally available.	1. Reports from contractor. 2. Report from host country. 3. Field review and evidence. 4. Physical existence of the materials in the soils and resource information service center.	Interest on part of host country is sufficient to maintain support for duration of the project. Staffing and acquisition of materials will be provided as requested. Project will be supported and research results will be utilized.

Inputs:	Implementation Target: (type and quantity)		Assumptions for Providing Inputs:
Contract personnel in the United States. Contract personnel in the field. Development of service facilities in Yemen. Training programs for involved personnel. Soil analysis and testing of samples. Host country support.	Two-phase, five-year program planned originally. Presently two-year (first-phase). Maintain annual financial support. Provide for a total of 96 man-months of U. S. personnel commitment in U. S.; 18 in Yemen. Maintain strong working relations in host country. Training of Yemen personnel to carry major work later in the project (36 man-months training).	1. AID records. 2. Contractor reports and records. 3. On-site investigation.	AID funding will permit project operation. Contractor can and will provide necessary qualified personnel. Host country relationships maintained at suitable level to allow productive work schedule.

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

ANNEX B

UNITED STATES GOVERNMENT

Memorandum

TO : NE/CD, Mr. Selig A. Taubenblatt
THRU : NE/CD, Mr. Leonard Rosenberg

DATE: April 20, 1978

FROM : NE/TECH, William F. Gelabert

SUBJECT: Initial Environmental Examination

Project Location	:	Yemen
Project Title	:	Land Classification and Soil Survey
A.I.D. Funding (Fiscal Year and Amount) Grant	:	FY 1978 $12,400 FY 1979 $298,400 FY 1980 $184,000
Life of Project	:	24 months
I. E. E.	:	Prepared by Victor Lateef, NE/TECH/AD
Environmental Action	:	Negative Determination
Date	:	April 20, 1978
Concurrence	:	NE/TECH/AD, Russell O. Olson GC/NE, Gary Bisson

NE Decision

Approved D. J. Brennan

Disapproved _____

Date _____

5010-110

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

CONTENTS OF INITIAL ENVIRONMENTAL EXAMINATION

I. Examination of Nature, Scope and Magnitude of Environmental Impact

Description of Project

1) To provide an inventory of land resources and land use information for future agricultural development in Yemen.

2) To assist the Y.A.R.G. in the preparation of a land use classification that will include Level I and Level II systems of soil use classification.

3) To assist the Y.A.R.G. in the preparation of land use maps by use of Landsat imagery and truth finding measures consisting of the collection of soil samples and their analyses.

4) To train Yemeni participants in soil science and imagery interpretation.

II. Action Recommended: Mission recommends a negative determination.

III. Comments on Major Environmental Relationships of Project Relevant to Attached Impact Identification and Evaluation Form

The basic changes which the project will bring about in terms of the environmental impact are as follows:

1) A better inventory and identification of land resources and a more intensive and judicial use of these resources.

2) An elimination of traditional fallow land practices.

3) An alternation of land use patterns and development of crop diversification.

4) The use of increased chemical plant nutrients especially nitrogenous and phosphate fertilizers to improve crop yields on a per unit basis.

5) Make better use of improved cultivation equipment in seed bed preparation.

6) Improve livestock production and make better use of appropriate lands to grow leguminous grasses for livestock feed.

The significance of each of these changes are as follows:

1) In place of the uncontrolled fallow land during which time is grazed by livestock; the planting of the land in legume crop species and small grain will be practiced. The impact of this change will be beneficial.

The grazing animals on the fallow land during the rainy season will have an adverse effect on the soil structure. Whereas the planting of forage crops for orderly cutting, grazing and/or harvesting will eliminate this adverse factor. In addition the planting of forage legumes will have a beneficial effect on the soil by adding to its nitrogenous content and improving the soil structure with its deep soil penetrating root system, especially on sloping land.

2) The elimination of large fallow land areas with crop producing plants will add to the benefits derived from the soil and immeasurably reduce soil erosion in Winter and evapo-transpiration losses in the Summer months.

3) The projected levels of land use patterns with crop rotation and diversification of crop types along with accompanied improved soil management will have a positive impact on soil texture and soil toxonomy.

4) The projected levels of increased utilization of nitrogenous and phosphate fertilizers will still be substantially below levels used in other areas of the world with intensive agriculture and which characteristically use high quantities of fertilizers. The soil types W 45° Longitude in Yemen are mostly clay and heavy clay loam and preclude significant leaching of chemical nutrients into groundwater. Therefore the impact on the soil and the environment is infinitesimal.

5) The better utilization of improved equipment in seed bed preparation, weeding, harvesting and other crop cultivation requirements will expedite farming operations in a timely fashion thus resulting in improved soil/plant relationships and absence of crop loss and spoilage. This will have a positive impact on the soil structure and the environment.

6) The projected livestock levels of increased livestock production will require more intensive livestock management and improvement in their diets. Forage production, storage of fodder and feed concentrates will improve animal nutrition. Also there will be a greater selectivity of animals by replacing goats with cattle and sheep. The resultant reduction in animal overgrazing, especially goats who consume the rootsystem of plants, will be beneficial in reducing soil erosion on sloping land. This will have a positive impact on land and environment.

The socio economic impact of this project would be classified as beneficial as follows:

1) Farm family income will increase and it will be within their economic reach to upgrade their standards of living.

2) Labor utilization will increase as more Yemeni migrant laborers return to their country to partake in its agricultural development.

3) Women now burdened with excessive farm labor responsibilities while their men folk are away will have more time to give to their domestic and family responsibilities.

The project will generally have a beneficial population impact.

IMPACT IDENTIFICATION AND EVALUATION FORM

Impact Areas and Sub-areas	Impact Identification and Evaluation[1/]
A. LAND USE	
1. Changing the character of the land through:	
a. Increasing the population	N
b. Extracting natural resources	N
c. Land clearing	N
d. Changing soil character	N
2. Altering natural defenses	N
3. Foreclosing important uses	N
4. Jeopardizing man or his works	
5. Other factors	
B. WATER QUALITY	
1. Physical state of water	N
2. Chemical and biological states	N
3. Ecological balance	N
4. Other factors	

1/ N - No environmental impact
L - Little environmental impact
M - Moderate environmental impact
H - High environmental impact
U - Unknown environmental impact

C. ATMOSPHERIC

1. Air additives N
2. Air pollution N
3. Noise pollution N
4. Other factors

D. NATURAL RESOURCES

1. Diversion, altered use of water N
2. Irreversible, inefficient commitments N
3. Other factors

E. CULTURAL

1. Altering physical symbols N
2. Dilution of cultural traditions N
3. Other factors

F. SOCIOECONOMIC

1. Changes in economic/employment patterns N
2. Changes in population N
3. Changes in cultural patterns N
4. Other factors

BEST AVAILABLE DOCUMENT

G. HEALTH

1. Changing a natural environment — N
2. Eliminating an ecosystem element — N
3. Other factors

H. GENERAL

1. International impacts — N
2. Controversial impacts — N
3. Other factors

I. OTHER POSSIBLE IMPACTS (not listed above)

Prepared By: Victor Lateef Date: 4/20/78

Project Location: Yemen

Project Title: Land Classification and Soil Survey

ANNEX C

Waiver of Host Country Contribution

Sana cable 4020 of 8/15/78 and AID/W cable 211050 of 8/18/78 are reproduced below:

SUBJECT: Land Classification and Soil Survey (279-0042):
Section 110 (a) Waiver

ACTION: SecState WASHDC PRIORITY

UNCLASSIFIED SANA 4020

AIDAC

1. This is to formally request the Assistant Administrator's (NE Bureau) waiver of section 110(a) with respect to the Yemen Arab Republic's meeting a 25 per centum contribution to project 279-0042, Land Classification and Soil Survey. Request is per Hdbk 3, Part I, App 3-D. Text of proposed memo to AA follows:

2. Request for waiver of Section 110(a) is justified on the grounds that the nature of the activity does not lend itself to any significant host-country contribution at this point nor during the life of project. All project activities with the exception of ground truth analyses/soil surveys will occur in U.S. However, successful attainment of project objectives will generate significant host-country (and possibly USAID) follow-on development activities in agriculture. The number of post-project activities expected to be initiated by the host-country as a direct result of this project will certainly surpass USAID's contribution under this project (dols 486,000) by a sizeable ratio. The identification of soils and their potential use will provide a key step in furthering the introduction of new technology in crop production by the host-country, other donors and USAID.

3. Project Rationale/Objectives:

A. Rationale - To date, Yemen does not possess an inventory of its natural resources nor indications of its use or potential development. Requisite to sound development planning in the agriculture sector with the objective of increased food production is possession of an adequate data base regarding existing and potential land utilization. Yemen's harsh topography is such that previous resource identification is limited but new technology in the form of satellite imagery and selected ground truth observation provides a particularly cost-efficient means of providing the YARG with timely information on its resources. Moreover, it is a field in which the U.S. is uniquely skilled/experienced.

B. Objectives - The purpose of this project is to provide an inventory of land resources and land use in Yemen and consequently strengthen the agricultural planning and development capabilities of the YARG. Also, the

project is to provide for a moderate institutional capability to interpret satellite imagery and conduct soils analyses with the potential for future expansion and development within the Ministry of Agriculture. Specific objectives in support of the above will be:

1) The development of land use maps

2) The development of soils maps based upon ground truth observation, testing and classification.

3) The development of maps indicating land use patterns from 1972 to present

4) The academic/special training of one to two Yemeni soil scientists.

4. Host country contribution in support of above will be salaries of technicians estimated at dols 20,000 and in-kind provision of office space/ library for data produced estimated at dols 20,000 for a total of dols 40,000 for two year LOP.

5. Request priority response so that Mission Director may proceed sign PP and obligate funds via limited grant agreement during August.

RANSOM

STATE 211050

SUBJECT: Land Classification and Soil Survey (279-0042) Section 110

REF: Sana 4020

On basis of justification contained in reftel requirement for 25 percent contribution by Yemen Arab Republic Government for Land Classification and Soil Survey Project 279-0042 is hereby waived.

VANCE

ANNEX D

REQUEST FOR ASSISTANCE

This project has evolved to its current form as a result consensus arising from continuing discussion and analysis on the part of USAID/Yemen and the YARG. Consequently, a formal letter of application has not been submitted. Now that the project has been finalized, the Mission has requested that a pro-forma letter of application be submitted to formalize our current agreements with the YARG. This letter is expected on or about the time the Project Agreement will be signed.